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AN
INAUGURAL DISSERTATION:
CONTAINING AN
E N Q U I R Y
INTO THE
EXISTENCE OF THE LIVING PRINCIPLE
AND
C A U S E S
O F
A N I M A L L I F E.

SUBMITTED TO THE EXAMINATION OF THE
REV. JOHN EWING, S. T. P. PROVOST;
THE MEDICAL PROFESSORS AND TRUSTEES OF THE
UNIVERSITY OF PENNSYLVANIA,
FOR THE DEGREE OF DOCTOR OF MEDICINE.

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Societies.*

Know then thyself, presume not God to scan;
The proper study of mankind is Man. POPE.

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TO BENJAMIN RUSH, M. D.

Professor of the Institutes and of Clinical Medicine, in the University of Pennsylvania, &c,

WORTHY SIR,

I HAVE taken the freedom to prefix your name to the following Thesis ; and I wish it had been in my power to have rendered it less unworthy your acceptance. I beg the favour of you to receive it as a testimony of my respect for the many civilities and acts of friendship with which you have been pleased to honor me.

Believe me to be,

With the profoundest esteem,

Your obliged,

Humble servant,

THE AUTHOR.

Preliminary Observations.

AUTHORS and the public together, have rendered Prefaces, and Introductions, necessary preludes to almost every publication. Authors on the one hand, imagine that a preface composed of encomiums on the contents of their books, is the surest method to procure them a favorable reception—While the public on the other hand, think themselves highly insulted if an author ventures to shew his head without an apologizing introduction.

In this Dissertation, however, I am resolved to omit both preface and introduction—Preface, because I am neither disposed to adulate my own work, or presuppose an inability in my readers to judge of its merits—Introduction, because I believe the world will interest themselves but little about it; and the few individuals whom I shall trouble with it, are men of too much sense, to feel themselves injured by this small piece of neglect.

INAUGURAL DISSERTATION.

AN ENQUIRY into the nature of Animal Life is of the first importance. That man who best knows the tenure on which we enjoy life, will be best able to regulate the animal machine in all its different deviations from the standard of health ; and like the skilful mechanic, who suits the agency of his pendulum to the strength of his clock, will apply such powers to the condition of the system, as shall preserve a harmonious and uniform vibration throughout its complicated functions ; till casualties, or time, annihilate the order of motion, and the agents unable longer to protract human existence, surrender the mutilated machine to that inanimate mass from which it first rose by the hand of its great Creator.

It is, however, to be regretted that the subject, from its own intricacy and intimate connection with metaphysics, is too far removed from human comprehension for juvenile attempts, to afford adequate solutions to all the laws and phenomena of the animal œconomy.

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Since the days of Hippocrates, physiologists have compared the human, and every other animal body, to a circle; and considered the actions and functions of its different parts in a separate state, and in a state of mutual dependence on each other, round the whole machine; inasmuch that their order was not only entirely artificial, but at whatever part they began, they were obliged to assume, as known, the action of some organ which influenced that of which they first treated. And after having described separately the several parts of the system they omitted what was most worthy of attention, the causes which gave motion to the primary functions of the body; and taught us to believe, that every animal body was a self-moving machine.

Dr. Cullen was the first, as appears from the observations of Dr. Brown, and the testimony of Dr. Rush, who asserted the dependent state of the human body; and taught us, that its movements did not depend on any particular internal constitution, but upon external agents.

Dr. Rush, who studied in Edinburgh at the promulgation of this doctrine, imbibed it from Dr. Cullen's lectures; and delivered it, in this school, as early as the year 1771, in the following words: * "The human body is not an automaton or self-moving machine, but is kept in motion, by the constant action of stimuli upon it."

Dr. Brown.

* Lectures on Physiology.

Dr. Brown, however, was the first who publicly declared, "That Life was a forced state;" on which text he has many aphorisms in his Elements of Medicine.

This theory, let it have been first suggested by Cullen, first taught by Rush, first published by Brown, resembles the majestic oak, which not the thousand dusky visions that may float around its foliage, shall ever wither or obscure.

During this progress of physiology, philosophers, bewildered in a labyrinth of obscurity, and guided by the dark tracts of imagination, supposed, at a very early period, that the human body possessed a living principle independent of the mind. It was used by different authors, by distinct appellations, but with a small and confused difference in their several significations. As the *plastick nature*, of Pythagorus and Plato, *Archius*, of Van Helmont, reduced to *Anima Medica*, of Stahl, *sentient principle* of Whytt, and *vis medicatrix naturæ* of Cullen. These opinions were chiefly directed to explain those actions of the living body, both in health and disease which become the most important objects of a physician's attention. They, however, like the subtle ether, for want of cohesion, have, on exposure, either evaporated into circumambient vacuity; or fallen sacrifices to the theories of succeeding physiologists.

I except here the doctrine of the Principle of Life, revived by Mr John Hunter, and attempted to be confirmed by some eminent physiologists of our own time : The theory is ingenious, has many supporters, and from the many shadows of plausibility which it carries in its countenance, is calculated, when viewed at a distance, to make conveitive impressions on the minds of its unscrutinizing readers.

But as it seems fitted to restore the theory of occult qualities, under the specious title of principles, should it extend itself among persons less enlightened than its present defenders, a view of its connections with reason and facts becomes desirable. It may seem like throwing a presumptuous gauntlet, in me, to attempt it ; but, as in the course of this dissertation, I intend to advance propositions very opposite, and think it essentially compatible with their future adoption, to remove every obstacle which can intercept their passage into the minds of a scrutinizing public ; I hope I shall be indulged with a few strictures on this doctrine, particularly in this happy enlightened period of science, when dogmas and assertions are followed, under the authority of great names, no farther than they are supported by facts or experience.

I will not take the advantage of the subject as treated by any particular gentleman, but will mention all the proofs that I can recollect in favor of the doctrine, as suggested

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by all its advocates ; endeavor to answer them by facts and natural inferences ; and oppose some difficulties sufficient, in my opinion, to refute the testimonies of its existence. The proofs most insisted on, for the support of a living independent principle, are,

I. Contraction of Muscles separated from the body.

II. The performance of the vital motions without consciousness of the mind.

III. The birth of full grown foetuses without a Brain.

IV. The temperature of the human body being always at a particular degree.

V. The Punctum Saliens being the first motion in the Chick ; and,

VI. Eggs freezing with more difficulty in proportion to their newness, from the time they are first laid, until they become putrid.

1. The power of contraction in a muscle in man is lost in a very few hours, in cold animals within twenty-four after death. The contractile power is lost before putrefaction begins, or rather before the texture of the muscle is destroyed, and decreases in strength after its first separation from the body to its cessation. Now, if this vital principle was a constituent part of the muscle, this
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ought not to happen, but the muscle ought to contract without the application of any stimulant, and continue to act until it was entirely destroyed : because by a principle we mean some original matter, or operative cause, capable of existing under some modification of matter for ever, and in the same sense Dr. Gardiner uses the principle of life :* “ By the living principle (says he) is understood that power in an animal, which actuates its whole system, and is capable of existing some time under a suspension of all its actions.”

2. Stimulants applied to the medulla oblongata, or the nerves themselves, produce stronger contractions than the irritation of the muscles themselves.

Dr. Whytt † made an experiment on a frog, which demonstrates that the action of the separated muscle depends on the nervous energy. “ Five minutes after taking out the heart of a frog, I injected a solution of opium in its stomach and guts. In less than half an hour it seemed to be quite dead ; for neither pricking or tearing its muscles produced any contraction in them, or any motion in the members to which they belonged. After cutting off its head, a probe pushed into its spinal marrow made its fore legs contract feebly.”

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* Gardiner's Animal Economy p. 342.

† Obs. on Irritab. and Sensib. exp. ii. 310.

The heart being taken out in this experiment, and circulation stopped, the opium only acted on the nervous system, which remained entire, and the nervous power being destroyed by it, the irritability of the muscles was in consequence destroyed. This should not have been the case was the doctrine of the living principle true, which, Mr. Hunter says, produces every action in the living animal, and that no part of the body is dependent for action on another. The last part of this experiment proves the fallacy of this assertion, and shews the dependence of the irritability of the muscles on the nervous system; for the irritability of the muscle was restored, by exciting the remainder of the nervous energy contained in the spinal marrow, by the stimulus of the probe, which contracted the frogs legs.

3. It might be urged against an independent vital principle, that there is too much design in all the actions of the voluntary muscles to be influenced by any cause less than the exertions of the will, directed by reason and judgment. Even the convulsion of a limb by the electric shock does not take place without consciousness.

II. With respect to the second argument drawn from the performance of the involuntary motions I shall only observe,

1. That granting those organs to be subject to the nervous influence, which cannot be denied, their motions may
satisfac-

satisfactorily be accounted for on the stimulus of their contained fluids.

2. That respiration is under the influence of the will, and the action of the heart, through the medium of the respiration, has in one instance been suspended by the will.*

III. The third argument drawn from the want of a brain, in full grown foetuses, and of which the defenders of the vital principle triumph and swagger not a little, tends to an entire subversion of the use of the brain. Foetuses have been born without a heart; and this fact would equally disprove the necessity of the heart in circulation: But foetuses born without a brain do not generally survive birth.

Dr. Haller supposes, with great probability, that in these accidents the brain is not originally wanting, but is destroyed by disease during the growth of the foetus. If the brain was not essentially necessary for the continuance of life, the independent living principle, in the cases where it has been absent, might have "actuated the systems" of those few who have unfortunately died in consequence of its absence.

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* Dr. Cheyne relates the case of a Col. Townsend, who could suspend the vital motions at pleasure, which can be accounted for in no other manner. Vid. English Malady.

If we admit the rational solution of Dr. Haller, it will be easy to conceive how life exists, in the very short and imperfect state it does, from a knowledge of the attachment of the nervous energy to the nerves in their whole course, (to be hereafter proven).

IV. The temperature of the body being always the same, is asserted by Dr. Gardiner to be occasioned by a resisting power of the living principle.

That the temperature of the human body should always remain stationary at 98° , may be now naturally explained, on the pneumatic theory of animal heat, with the aid of an experiment (too much neglected) which is recorded by Crawford, and proves that the absorption and decomposition of vital air in the lungs, with the external sources of heat, are in an exact ratio to each other. Should either of these sources be excessive, the evaporation of the perspirable matter (the common consequence) generates cold in proportion to its profuseness, by which means the heat is so exactly regulated, that the medium degree in all men is in all climates nearly the same.

This fact being granted, if only in conformity to that law of Sir Isaac Newton, which teaches us to admit no more causes than are true, and sufficient to explain the phenomena of natural things, we should reject this resisting principle in animals as absurdly hypothetical.

V. The punctum falienſis, or motion of the heart, being the firſt vital motion obſervable in the chick, is ſuppoſed the fifth proof in favour of a living principle. This fact, by no means diſproves the independency of the heart's action; * Malpighi has demonſtrated, that the incipient chick appears at firſt to be nothing but brain and ſpinal marrow, the two eyes alſo appearing viſible. The heart is obſerved forming in a gradual manner ſome time after, and ſeen completed before its pulſation. Haller's † experiments evince nearly the ſame truths.

From theſe facts, the above argument will afford the votaries of the living principle no ſupport; it is evident the brain is complete ſome time before the formation of the heart, and may afford it nervous energy ſo as to be irritated by the blood.

VI. The ſixth argument drawn from the experiments of Mr. Hunter, which are that a putrid egg freezes ſooner than a ſtale one, and that a ſtale one freezes ſooner than one new laid, prove nothing. If this principle reſided in an egg that was prolific, every impregnated egg would equally reſiſt the effect of cold, and conſequently a ſtale egg, which will afford a chick, on incubation ſhould freeze no ſooner than an egg freſhly laid. But farther, if a principle

* Appendix de ovo incubato & plates.

† Opera Menora, Vol. ii.

ciple existed in an egg sufficient to actuate it, I would ask why is not the chick brought into existence without the application of heat and air? But to go farther, I do assert that the egg before incubation, possesses no life whatever. Life without motion is inconceivable, and * “it is only from a knowledge of death we gain an idea of life.” Now as there is no action in the egg (let it be ever so new) I think I am at liberty to conclude, that it does not possess the smallest visible property of animated nature. All that Mr. Hunter’s experiments on this subject prove, is, in my opinion, that fluids of different densities, or organization, freeze in different temperatures of the atmosphere.

The difficulties which seem most to oppose the existence of a living principle are,

1. Its destructibility.

That it is destructible needs only a quotation from one of its strenuous advocates†, “The living principle must be acted upon by stimuli, otherwise it loses its vigor, becomes languid, and is at last extinguished.” He also remarks that excessive stimuli destroy it. In the first part of this quotation, the Doctor has robbed the principle of the definition given by himself, and makes it a mere dependent

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* Hunter’s Lectures on the Principle of Life in his course of Surgery.

† Gardiner—See his Animal Economy, p. 23. sec. 16.

dent something, which cannot exist without a certain force of stimuli. But if a principle on which the system depended for its action were destroyed by stimuli, when excessive or defective, I would ask, how the body would be ever after actuated? It must certainly perish, would be the answer. This, though it would be a categorical answer with respect to the human body, would not be strictly true; because we have innumerable cases of death, from syncope, from cold, and from submerision where the body was reanimated after a suspension of all motion for several hours; and in all these cases, according to Dr. Gardiner, the living principle must have been *extinguished*.

But admitting the living principle to exist in the system in a latent state, which supposition they pretend to have a right to claim, if it be capable of actuating the body, which they all assert, I would ask why does not life return without the application of stimulants? If certain stimuli entirely destroyed the vital principle, so every stimulant, according to its force, must partially extinguish it: And as there is no power in the system to renew it, and as it exists in a "collected state:" so, logically inferring, it must constantly decline from the first breath of an animal; and a child could scarcely begin to enjoy life, when the principle which actuates it, must be annihilated by the stimuli that constantly surround it.

2. The immediate, and negatively occasioned death from an absence of the brain.

3. The effects of the passions and mania purely mental on the arterial system.

4. A fourth argument against the existence of a living principle is, that certain parts of the body, which receive no nerves, as the bones, cartilages, ligaments, &c. possess no irritability; whereas the adherents to that doctrine make the principle to pervade the whole system.

5. The impossibility to account for its accession to the foetus.

Dr. Gardiner was aware of this impossibility; but like those divines who believe in the immateriality of the soul, would only acknowledge it difficult. He asks if there is not a supply of it from the mother during the tender state of the foetus? I will reply to this question, by asking what remaining quantity (admitting it existed in a “collected state,”) a mother would retain after supplying twelve or fifteen children? To account for its formation, or its union with the body, they are then reduced to this absurdity, that the divine power is under the necessity of creating and applying it to the germ, at every fruitful coition, in the human species and every other animal.

In this dissertation I have only exposed such faults in the doctrine of the living principle as appeared to me most prominent. I shall conclude my strictures on it by observing, that while so many doubts occur respecting its existence, and while the supposition includes so many difficulties in its own nature, it is allowable to reject it in the solution of the laws of the animal economy, till more convincing proofs of its existence shall appear than have yet been offered to the public. At present it is evident we gain nothing by admitting the supposition, as no distinct account is given of the nature or production of this principle, and as an investigation of facts seems to lead us back to the brain as the source of irritability and sensibility.

I shall now proceed to deliver a few propositions in order to prove that life is an effect, and produced wholly by external impressions, acting upon the human body and mind.

I. It is a fact, that every part of the system, connected with the nerves, possesses Excitability; by which I mean, a property in the Animal Oeconomy which fits it to receive impressions from stimuli. I shall divide it into irritability and sensibility. By irritability I understand that condition of the contractile parts of the body, by means of which they are capable of motion. By sensibility is
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here meant that condition of the nerves, by means of which they become capable of deriving sensation from external objects through the medium of the senses.

This division of excitability will carry me to mark two distinct systems, on which stimuli act and produce different effects. The first, or irritable surface, I shall make the whole muscular, or contractile part of the body.

The second, or sensible system, I shall make the brain or Mind.

These two systems are intimately connected together by sympathy; and the mutual action of the body and mind on each other is felt every moment.

What this excitability is, modern physiologists have been unwilling to say, and content themselves with a knowledge of the fact without presuming to assert its qualities over which, nature, they suppose, has drawn an impenetrable veil. It is happy for the advancement of science that this opinion is not universal, and that the world yet retains a few of those men, who are sarcastically called Speculators: Were the idea generally adopted, physicians, surrounded as they now are with imperfections, might satisfy themselves with a knowledge that energetic tartar will vomit, that cold and heat, under certain circumstances, will produce catarrh, without being able to explain

explain their *modus operandi*, or *rather another* phenomenon in disease. I am clearly of opinion, and I think the day not far distant, when the operations of the nervous system will be as intelligible to us, as the circulation of the blood has been since the discovery of Harvey.

My II. proposition then is, that this excitability is Matter.

I shall endeavour to prove the truth of this proposition, by the enumeration of the general properties of matter; and shew, by experiment, that excitability possesses them.

The 1st. property of matter is *Extension*, or that affection by which it occupies part of space.

2. *Impenetrability*, or that property of matter by which two bodies cannot exist in the same place, at the same time. Dr. Priestley * has totally denied the necessity of this property in the composition of matter. I think it can only be used in a comparative sense, in which signification it may, from undoubted authority, be applied from the hardest diamond, which penetrates glass, to the invisible permanently elastic fluid, which composes the atmosphere. I shall, therefore, take the liberty to substitute *Resistance*.

3. *Inertia*,

* *Disquisitions on Matter and Spirit.*

3. *Inertia*, or that property by which one body resists a force impelling it to a change of state.

4. *Attraction*, or that property of matter, by which one body tends continually to approach another.

5. *Rest*.

6. *Motion*. The two last properties can only *exist in succession*.

The experiment which I shall relate to shew that this excitability possesses all the properties of matter (by which matter itself is only known), was first instituted by Bellini, and repeated by Dr. Monro with the same success. "After opening," says the Doctor, "the thorax of a living dog, catch hold of, and press one, or both of the phrenic nerves with the fingers, the Diaphragm ceases immediately to contract; then let go hold of the nerve, and the muscle acts again. Pinch a second time the nerve or nerves some way above the diaphragm, this muscle again ceases to act. Keep firm hold of the nerve, and with the other hand, strip or milch it down from the gripping fingers towards the diaphragm, and the muscle is made to contract; and for three or four milchings, its action follows or obeys the motion of the fingers which strip it down; then it becomes disobedient, and will contract no more milch, as you will find, unless the fingers gripping

er pinching the nerve let go their hold, or are moved higher upon the nerve, when the muscle may again be made to contract by stripping the nerve down towards it.”

This experiment proves,

1. That the extension or space occupied by the matter, which influenced the motion of the Diaphragm by its influx, was from the gripping fingers to the muscle.

2. That it does not exist in the same place at the same time with another body, but was forced to a change of state by the fingers.

3. The inertia of excitability is better verified by observations on the application of very slight stimuli which produce no emotion. This experiment, however, proves, that the force of the fingers overcame its resistance, and forced the nervous matter to a change of place.

4. That it has a greater attraction to the nerves than any other substance, and continues to adhere to them for several milchings.

5. That it was in motion before the compression of the phrenic nerves.

6. That it was at rest after the compression of the nerves by the fingers.

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This experiment proves farther, that the Diaphragm which is as involuntary as respiration, is dependent for its action on the nervous energy; and, if an influx of excitability is prevented, the muscle ceases to act. A fact not much in favour of an independent living principle.

We know so little about the essence of matter in general, that it will be difficult to say, what the precise peculiarities of this excitability are. I am inclined to think it is a matter sui generis, consisting of a certain arrangement, of certain particles, so fine as to acquire the properties of excitability as above defined.

The motion I suppose to be propagated in the same manner, to the different parts of the body, as Le Cat accounts for the communication of light from the sun to our earth*. That is, the particle nearest the stimulus is first put in motion, this excites the next, and so on, in the same instant to the most remote. Just as we see in elastic balls, regularly placed on a plain, a stroke at one end of the line, at the same moment, moves the most distant ball.

The above experiment renders this supposition very probable.—The cessation of the action of the diaphragm, immediately on compression of the phrenic nerve, is almost a proof positive, that the same particles of matter

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* Treatise upon the Senses.

that caused the diaphragm to contract, did not come directly from the fountain; for if they had their motion would have been continued into the muscle, and contracted it after the communication had been cut off between the brain and diaphragm. The Doctor's saying, strip the fingers *towards* the diaphragm, and the muscle is made to contract, implies, in my opinion, that it did contract, as soon as he began to milch the nerve.

My III. proposition is, that this excitability is secreted probably from the brain—

I infer it

1st. From the analogy of the brain to other glands. The brain resembling them in its own structure, and the nerves like secretory ducts conveying the secreted matter, to their several ramifications.

2. From the surplus of substance, more than sufficient to afford attachment for the nerves.

3. From the superabundant quantity of blood sent to the brain more than sufficient to nourish it, and greater than circulates through any part of the body of the same size; the blood being one-sixth of the whole mass, according to Dr. Haller—whereas the brain is only one-fortieth part of the body.

4. From

4. From no lymphatics having been discovered in the brain.

5. From the application of stimulants, or from the application of the body or mind, incessantly, to violent exercise, exhausting the excitability; and from the abstraction of stimuli and rest, as in sleep, not only generating fresh matter, but, if long continued accumulating it, beyond its usual bounds.

My IV. proposition is, that the nerves are the proper and sole conductors of this excitability, and that it is always attached to them from their origin the brain, to their terminations in the sentient parts of the system.

That the nerves are the conductors of this matter is evident from the compression or division of a nerve, which destroys sense and motion in the parts to which its branches are distributed. That it is attached to the nerves is proved by the experiment of Bellini, which demonstrates that although the communication is cut off from the brain by ligature, a sufficient quantity adheres to the nerve, to afford contraction in a muscle several times, if pushed on by any stimulus.

My V. proposition is, that stimuli produce different effects according to the systems on which they are applied—On the irritable system, motion.—On the sensible surface,

face, sensation, thought, and the passions. The truth of this proposition is evinced from irritating substances and volition producing immediate motion in the muscles, and from injuries of the spinal marrow (where sensation, thought, and the passions exist) from external impressions on the senses, without motion.

My VI. proposition is, that the excitability becomes accumulated on the abstraction of some stimuli, and the remaining stimuli act with proportionable force.

This proposition, when extended, explains in the clearest manner, the existence of Animal life, under all its forms, in different ages and conditions of the system.

Life, in more perfect animals is, by Dr. Goodwin, defined to be “The faculty of propelling the blood through the circulating system.”

This definition, I am inclined to think, is not sufficiently intelligible—it may carry an idea, that this faculty is inherent rather than communicative, in which sense Dr. Goodwin, as will appear in his work, does not wish to be understood.

Those who maintain an opinion that an animal possesses any innate faculty, by which the fluids are propelled
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through the circulating system, contradict facts, and take from an important organ, its only use.

I conclude, therefore, that Animal Life, in its most perfect state, consists in motion, sensation, mental action, and the passions. It is the true excitement of Dr. Brown, produced by stimuli acting on the excitability, as varied in irritability and sensibility. Hence we see the propriety of the observation of Dr. Rush*, “*That life is a mere quality, and as much an EFFECT, as sound from a bell, or music from a Violin.*”

The stimulants which produce Excitement or Animal Life, I shall divide into those that act on the irritable system, and without consciousness; and into those that act on the brain through the medium of the senses, with consciousness.

Under the first are comprehended *Pure Air—Heat—Exercise of the Muscles—Food*, including condiments and drinks—*Chyle—Blood*, and a tension of *certain glands*.

Under the second head, or those which act on the mind, I include the *qualities* of all objects which, applied to the diversified senses will produce sensation, the invigorating passions, emotions and thought.

Through

* Lectures on the Institutes of Medicine.

Through the medium of the sense of *touch* act certain *soft and smooth substances*—the sense of *taste, aliments*—the sense of *smelling, odors*—*seeing, light, colour, figure, height and magnitude*—And the sense of *hearing, sound*. Under the second head I also comprehend the *exercise* of the *understanding*.

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